

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056

In the matter of the petition of

Gulfstream Aerospace Corporation

for an exemption from § 25.901(c) of Title 14,
Code of Federal Regulations

Regulatory Docket No. FAA-2003-14257

PARTIAL GRANT OF EXEMPTION

By letter dated January 10, 2003, Mr. Richard J. Trusis, Director, Airworthiness & Certification and Data Management, Gulfstream Aerospace Corporation, P.O. Box 2206, Savannah, Georgia 31402-2206, petitioned for a partial exemption from the “no single failure criterion” of § 25.901(c) of Title 14, Code of Federal Regulations (14 CFR) as it relates to “uncontrollable high thrust failure conditions.” Recent studies and service experience indicate that some existing transport category airplanes do not strictly comply with § 25.901(c) for certain uncontrollable high thrust failure conditions. The partial exemption, if granted, would permit type certification of a similarly non-compliant derivative of the current Gulfstream Model GV airplane to allow installation of a later version of the BMW-Rolls Royce BR700-710 series engine.

The petitioner requires relief from the following regulation:

Section 25.901(c) which requires, in part, that “no single failure will jeopardize the safe operation of the airplane.”

The petitioner supports its request with the following information:

"A control system that might eliminate all failure modes of concern for the GV-SP would require significant modifications to the current engine control system and additional engine data and aircraft interfaces to allow independent monitoring and reversionary control or engine shutdown. This would significantly increase the complexity of the engine control system and possibly introduce other failure modes that would adversely affect the overall level of safety of the engine and therefore the aircraft."

"Aside from introducing additional complexity, thus additional failure modes, a redesign of this unmodified previously approved engine control system would add significant cost and schedule impact to the Gulfstream Model GV-SP program."

"Gulfstream competes for new business all over the world".

"This exemption will directly impact the ability to certify the GV-SP aircraft thereby having a direct effect on GV-SP Sales. The manufacture, completion and support of [GAC] aircraft aids in the stabilization of the job market as well as the growth of the American economy, which is certainly in the interest of the public."

"Requiring the GV-SP to comply with this rule would prevent Gulfstream from certifying the aircraft on a timely and competitive schedule, putting it in an unfair disadvantage to its competitors in Europe and with other foreign aircraft manufacturers."

"GAC intends to show the GV-SP thrust control system meets extremely remote conditions for the hazards as established in the AIA/AECMA Project Report on Strategies for Protection from Thrust Control System Malfunctions, dated 1 July, 2002."

"[GAC] agrees to demonstrate that all practicable actions have been taken to minimize the adverse effect on safety associated with granting of the exemption from 14 CFR 25.901(c) for the GV-SP BR700-710C4-11 series aircraft."

"[GAC] has committed to demonstrate that the GV-SP BR700-710C4-11 exposures and failure rates are such that this airplane should not exceed the known average per flight hour risks of comparable existing transport airplanes."

"...[GAC] will develop and obtain FAA approval of a document listing those failures that can contribute to, or cause an uncontrollable high thrust failure condition covered by this exemption. This document shall be made available for proper development of the instructions for continued airworthiness. Further, the failures listed within this document shall be considered mandatory reportables to the FAA under 14 CFR § 21.3, for any airplane certificated under this exemption."

Notice and Public Procedure Provided

A summary of this petition was not published in the Federal Register as the nature of this partial exemption is effectively identical to those of previous petitions for which there were no public comments received.

The Federal Aviation Administration's (FAA) analysis is as follows:

Background

Uncontrollable High Thrust Failure Conditions

Numerous single and anticipated combinations of failures within traditional turbojet engine control systems result in losing the normal means to control thrust (i.e., control via the throttle lever, autothrottle, etc.). A subset of the resulting failure conditions may include actual thrust either increasing to higher than commanded and/or remaining high when low thrust is commanded. These “Uncontrollable High Thrust Failure Conditions,” and the hazards they pose, have long been inherent in transport airplane designs. In fact, the “fail-safe” states for engine controls have traditionally been chosen to protect high thrust capability and allow the flightcrew to decide when an engine shutdown is appropriate.

An initial estimate indicates that over the last 20 years the average rate of occurrence for the uncontrollable high thrust failure condition on turbofan-powered large transport category airplanes has remained relatively constant at around one every 2.5 million flight hours. This would indicate that to date an “Uncontrollable High Thrust Failure Condition” has occurred hundreds of times without resulting in a single reported serious injury.

When these failure conditions were identified during past certifications, compliance was typically based on accepting an assertion that the flightcrew will recognize and safely accommodate the loss of the normal means to control engine thrust, including shutting down the affected engine via an independent fuel shutoff as required. However, recent engineering studies and service experience, including a 1997 Saudi Arabian Airlines Boeing 737-200 accident, indicate this traditionally accepted assertion is not always valid. For those airplanes re-evaluated to date, the available failure recognition and accommodation time under certain anticipated operating conditions is so short and the required corrective actions sufficiently unnatural that the flightcrew cannot be relied upon to reliably and completely perform those actions before the safe operation of the airplane is jeopardized.

The FAA is responding to this revelation by developing a “Thrust Control Malfunction Airworthiness Program” to consistently and objectively assess and manage the existing and future transport airplane fleet risks associated with this endemic potential for non-compliance and unsafe conditions. The ultimate goal of this program will be to bring the transport airplane fleet back into compliance as quickly as practicable. The interim goal of this program will be to manage the risk associated with each instance of non-compliance so that it does not represent an unsafe condition.

As part of this program, the FAA has begun requesting more effective validation of any type certification assertions that the flightcrew will recognize and safely accommodate the loss of the normal means to control engine thrust. Such a request is what led Gulfstream to submit the subject petition for exemption from the "no single failure" provision of §25.901(c). Compliance with that provision would require that each identified single failure be assumed to occur under any and all anticipated combinations of airplane operating and environmental conditions. While the single failures themselves must be assumed to occur regardless of their probability¹, probability can be considered when determining what combinations of operating and environmental conditions are anticipated to occur in the fleet life of the airplane type. Single failures do not need to be assumed to occur under conditions that are in and of themselves not expected to occur.

The FAA has concluded that, despite this recent revelation, strict compliance with the “probable² combination of failures” provision of §25.901(c) should remain practicable. Conversely, until practicable design solutions can be identified, validated, and safely integrated into turbine engine control system type designs, the FAA has concluded that it can be in the public interest to continue to certificate derivative type designs, especially design improvements, even if they don't strictly comply with the "single failure" provision of § 25.901(c).

The conditions established by the FAA for granting this partial exemption, when applied to the proposed design change, are intended to take full advantage of each practicable opportunity for improvement while affording the petitioner all warranted flexibility to certificate a non-compliant derivative design.

¹ While probability has been an acceptable means of supporting a finding that a particular "combination" of failures are not "probable", any single failure where the physics of the failure can be identified is typically "anticipated to occur" unless that occurrence within the relevant exposure can be clearly and acceptably ruled out, as is the case for those structural failures specifically excepted by the rule itself.

² The term "probable," as used in § 25.901(c) has a very different meaning than the same term as subsequently used in association with § 25.1309(b) compliance. As used in §25.901(c), "probable" means "foreseeable." In §25.1309(b) terms, this means the subject failure conditions are "anticipated to occur" (i.e. aren't "extremely improbable").

Gulfstream Model GV Airplanes & BMW Rolls Royce BR700-710 Engines

This partial exemption is applicable to the Gulfstream Model GV-SP, which is a derivative of the existing Gulfstream Model GV. The BMW-Rolls Royce BR700-710C4-11 engines to be installed on the GV-SP are a derivative of the BR700-710A1-10 engines installed on the existing GV. As indicated in the petitioners request, the engine control system for the GV-SP will be essentially identical to that of the existing GV airplanes. Only minor operational and thrust management changes have been incorporated to allow the engine maximum takeoff rated thrust to be increased by approximately 7%. The existing independent overspeed protection limits for the failure conditions are not affected by these operational and thrust management changes. The petitioner has indicated that there are several single failures and combinations of failures that can cause either the existing or proposed derivative BR700-710 series engines to produce high thrust, up to the level where the first independent limiter (governor) is encountered, while not responding to the throttle lever. Further the petitioner has indicated that this may jeopardize the safe operation of any GV series airplanes if it occurs during some particular takeoff or landing conditions.

The petitioner intends to demonstrate that those combinations of failures that could jeopardize safe operation comply with § 25.901(c) in that they are not “probable combinations.” Conversely, the petitioner does not always intend to demonstrate that those single failures which could jeopardize safe operation comply with § 25.901(c). Consequently, in order to certificate the installation of the BR700-710C4-11 engines on the Gulfstream GV-SP airplane, the petitioner must either obtain this exemption or substantially modify the associated engine control system design. As delineated in the petitioner’s supporting information, the petitioner has concluded that the exemption is the option which best serves the public interest.

FAA Analysis - Introduction

To obtain this partial exemption, the petitioner must show, as required by § 11.81(d), that granting the request is in the public interest, and, as required by § 11.81(e), that the partial exemption will not adversely affect safety, or that a level of safety will be provided that is equal to that provided by the rules from which the partial exemption is sought.

FAA Analysis - Public Interest

The petitioner will be required by the conditions in this partial exemption from § 25.901(c) to demonstrate that all practicable actions have been taken to minimize the adverse effect on safety associated with the design change. This condition assures that granting the partial exemption will be in the public interest. That is, any risks associated with non-compliance must be eliminated or further reduced wherever the FAA finds that to do so is technologically feasible and cost beneficial for the public. This has traditionally been accepted as the level of safety which is “in the public interest.” Furthermore, if bringing the airplane into compliance is found to be a “practicable action,” then this partial exemption would in effect be self eliminating.

In consideration of the above, the FAA concludes that granting this petition is inherently in the public interest.

FAA Analysis - Effect on Safety

The petitioner will be required by the conditions for granting this partial exemption to demonstrate that the risks due to uncontrollable high thrust failure conditions on any airplane certificated under this partial exemption will not exceed those currently known and accepted for comparable existing transport category airplanes. Making this a condition of this partial exemption, in combination with the condition to minimize that risk, means that granting this partial exemption should not adversely affect and, in fact, should improve the average per flight hour risk within the current transport airplane fleet.

For those existing transport airplanes re-evaluated to date, the conditions under which an uncontrollable high thrust failure may jeopardize the safe operation of the airplane are limited to specific aborted takeoff or approach and landing scenarios. Given that these scenarios occur, there is still a low probability that any serious injury will result. This limited exposure, in conjunction with the historically low occurrence rates, make this a relatively low per flight hour risk. This assessment is supported by the fact that the 1997 Saudi Arabian Airlines Boeing 737-200 accident is the only one attributed to these types of failures and there were no serious injuries in that accident.

It is the spectre of this low per flight hour risk accumulating indefinitely on many, if not most, existing and future transport airplanes that is the primary concern driving development of the FAA “Thrust Control Malfunction Airworthiness Program.” To date, corrective actions under 14 CFR part 39 have only been deemed warranted when the uncorrected risks for a particular type design were considered significantly greater than those required by the conditions and limitations of this partial exemption. Given that these conditions and limitations require any airplane certificated under this partial exemption be expected to have an uncontrollable high thrust failure rate over three times better than the current fleet average, the impact of adding these Gulfstream Model GV-SP fleet hours to the overall transport fleet exposure should be insignificant. Furthermore, if as part of the “Thrust Control Malfunction Airworthiness Program” the FAA determines that additional generally applicable precautions must be taken, including perhaps some future introduction of a compliant design, these will further minimize any cumulative risk impact of granting this partial exemption.

This partial exemption inherently implies a somewhat greater hazard than full compliance with § 25.901(c). This is why the FAA intends to bring the transport fleet back into full compliance as soon as practicable. Nevertheless, the fact that the per flight hour risks associated with this non-compliance are low allows us to develop a well considered recovery program to assure we don't introduce a problem which is worse than the one we are trying to solve and that this recovery program is clearly in the public interest.

In consideration of the above, the FAA concludes that granting this petition will not adversely affect safety.

The Partial Grant of Exemption

In consideration of the foregoing, I find that a partial grant of exemption is in the public interest and will not adversely affect safety. Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701, delegated to me by the Administrator, Gulfstream Aerospace Corporation is granted a partial exemption from § 25.901(c) to the extent necessary to allow type certification of the Gulfstream Model GV-SP airplane with BMW-Rolls Royce BR700-710C4-11 engines without an exact showing of compliance with the requirements of § 25.901(c) as they relate to single failures resulting in uncontrollable high thrust conditions. This partial exemption is subject to the following conditions and limitations:

1. Gulfstream Aerospace Corporation must demonstrate, in accordance with an FAA-approved “Airworthiness Assessment and Risk Management Plan,” that all practicable actions have been taken to minimize the adverse effects on safety associated with granting this petition. These must include, but are not limited to, practical actions to eliminate or further reduce the risks by improving designs, procedures, training and instructions for continued airworthiness.
2. Gulfstream Aerospace Corporation must demonstrate, in accordance with an FAA-approved “Airworthiness Assessment and Risk Management Plan,” that the risks associated with exempting the “uncontrollable high thrust failure condition” from the single failure provisions of § 25.901(c) are no greater for the proposed Model GV-SP type designs than those currently known and accepted for comparable existing transport category airplanes. Acceptable risk for this provision can be characterized as:
 - a. The airplane complies with § 25.901(c) for any foreseeable uncontrollable high thrust failure conditions in flight, except possibly during approach below 400 feet; and
 - b. The expected frequency of occurrence of the uncontrollable high thrust failure condition is less than once per ten million airplane operating hours.
3. The following “Note” will be added to the airplane Type Certification Data Sheet for any airplane certificated under this partial exemption:

“The FAA has concluded that the occurrence of any uncontrollable high thrust failure condition, or any of the associated causal failures listed within Gulfstream Document (reference tbd), “may endanger the safe operation of an airplane” and hence are reportable under §§ 121.703, 125.409, and 135.415.”

In support of this “Note”, Gulfstream Aerospace Corporation must develop and obtain FAA approval of “Gulfstream Document (reference tbd)” which lists those failures that can contribute to or cause an uncontrollable high thrust failure condition covered by this partial exemption. This document must then be made available as part of the instructions for continued airworthiness. Further, the failures listed within this document must be added to the list of reportables under § 21.3 for any airplane certificated under this partial exemption.

4. The granting of this partial exemption does not relieve any regulatory obligation to identify and correct unsafe conditions related to uncontrollable high thrust failure conditions.

Note: Additional background and guidance regarding these provisions are provided in FAA Letter 02-112-02, dated October 19, 2001.

Issued in Renton Washington on March 17, 2003.

/s/
K.C. Yanamura
Acting Manager
Transport Airplane Directorate
Aircraft Certification Service